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Imapct of sea-level fall and gas hydrate dissociation on the surface and bottom environments of Japan Sea during the LGM

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A negative excursion in the oxygen isotopic composition of planktonic foraminifera for 32ka to 17 ka in Japan Sea has been explained to reflect the development of low-salinity event in surface waters toward the LGM. Well-stratified surface waters and limited vertical circulation are considered to have caused euxinic conditions in bottom environments, which are characterized by benthic foraminifera barren, thinly laminated, dark colored sediments. However, the present reconnaissance study on the benthic foraminifera and its isotopic signatures are likely to suggest that, on the one hand, the low-salinity event is not limited to surface waters but the entire Japan Sea water became low saline during the LGM. Secondary, the bottom water was not euxinic but more or less oxic as indicated by common occurrence of significant amount of benthic foraminifers and development of bioturbated units within the thinly laminated units. Five Japan Sea Isotope Stages (JS-1 to JS-5) have been defined on the basis of the oxygen isotopic composition of planktonic foraminifera for the last 100kyr, among which the JS-4 (32ka to 17ka) is characterized by negative excursion in the oxygen isotopic composition of both the planktonic and benthic foraminifers. Inflow of cold fresh water to Japan Sea significantly lowered the surface water temperature as well as to decrease the salinity of surface water. Because of enhanced cooling, the surface water became a bit denser than the underlying waters, then it sank toward the bottom. The salinity of Japan Sea waters were as low as 18 permil at 17ka. During LGM, the benthic foraminifera has been believed to have mostly extinct, however, as a matter of fact, a number of benthic foraminifers were clearly recognized in several locations of Japan Sea. Downward diffusion and mixing of the cold and less saline surface water transported dissolved oxygen to the bottom and then the benthos could survive even during the LGM. At 19ka, carbon isotopic composition of benthic and planktonic foraminifera showed remarkable negative excursion (-4.5 and -2 permil respectively) in a core recovered from the top of Umitaka Spur, Joetsu basin, where an active methane seepage and massive gas hydrate are observed. Because of no evidence for overgrowth and recrystallization, the negative excursion implies significant and sharp drop in carbon isotopic value of DIC. The U-Th ages of methane-induced authigenic carbonates are centered on 20ka, and Rutherfordoides rotundata, a characteristic species to live in methane-enriched conditions, preferentially occur in the LGM. Above lines of evidence strongly indicate that gigantic methane seepage and dissociation of gas hydrate occurred during the LGM. Expulsion of methane was so strong that surface waters have been also affected by C-13 depleted DIC.

Keywords: gas hydrate, joetsu basin, eastern margin of Japan Sea, foraminifera, oxygen isotopic composition, carbon isotopic composition